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Changes in Mining Pollution of the Northwest Miramichi River from June 30, 1960 to the end of 1963

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Development of These Studies

Since June 1960, scientists and technicians of the Fisheries Research Board of Canada have been studying the effects of copper-zinc pollution. The purpose is to find out the "safe" levels of mining pollution for fish. This knowledge is needed to set realistic goals for avoiding trouble with mining pollution in New Brunswick and elsewhere.

Much of this work has been done on the Northwest Miramichi River, which is polluted by a base metal mine on a tributary. Water samples have been taken from the river and analyzed for copper, zinc, and other factors. This was to serve as a chemical background for biological research. Biological studies have involved lethal tests, avoidance responses by fish, numbers of young fish in the river, and supply of aquatic insects used as food by fish.

While this basic research has been going on, many other groups have been studying mining pollution from different angles. The mine personnel have been observing the results of their control efforts. The Fish Culture Branch of Department of Fisheries has been monitoring pollution in several rivers by means of live fish held in cages. The New Brunswick Water Authority has co-ordinated activities of many agencies and provided a clearing-house of suggestions for water treatment. The Department of Lands and Mines has also been actively engaged.

The Pollution Scoring System

To describe pollution from the fish's point of view, a simple scoring system has been used. It takes into account the concentrations of both copper and zinc, and the effects of other natural variables in the water. The system was originally developed by fishery scientists at the British Water Pollution Research Laboratory. It was checked during three years of research at the St. Andrews Biological Station to make sure that it applied to young Atlantic salmon.

The pollution scoring system assigns a score of 100 to that degree of pollution which is just on the borderline of killing young salmon. All other degrees of pollution are expressed by comparison with this level. A score slightly higher than 100 indicates concentrations of copper and zinc which would be lethal in a day or two. Heavier pollution would kill fish more quickly. For example, the score 500 means that concentration of metals is 5 times the lethal level. This would kill young salmon in a few hours.

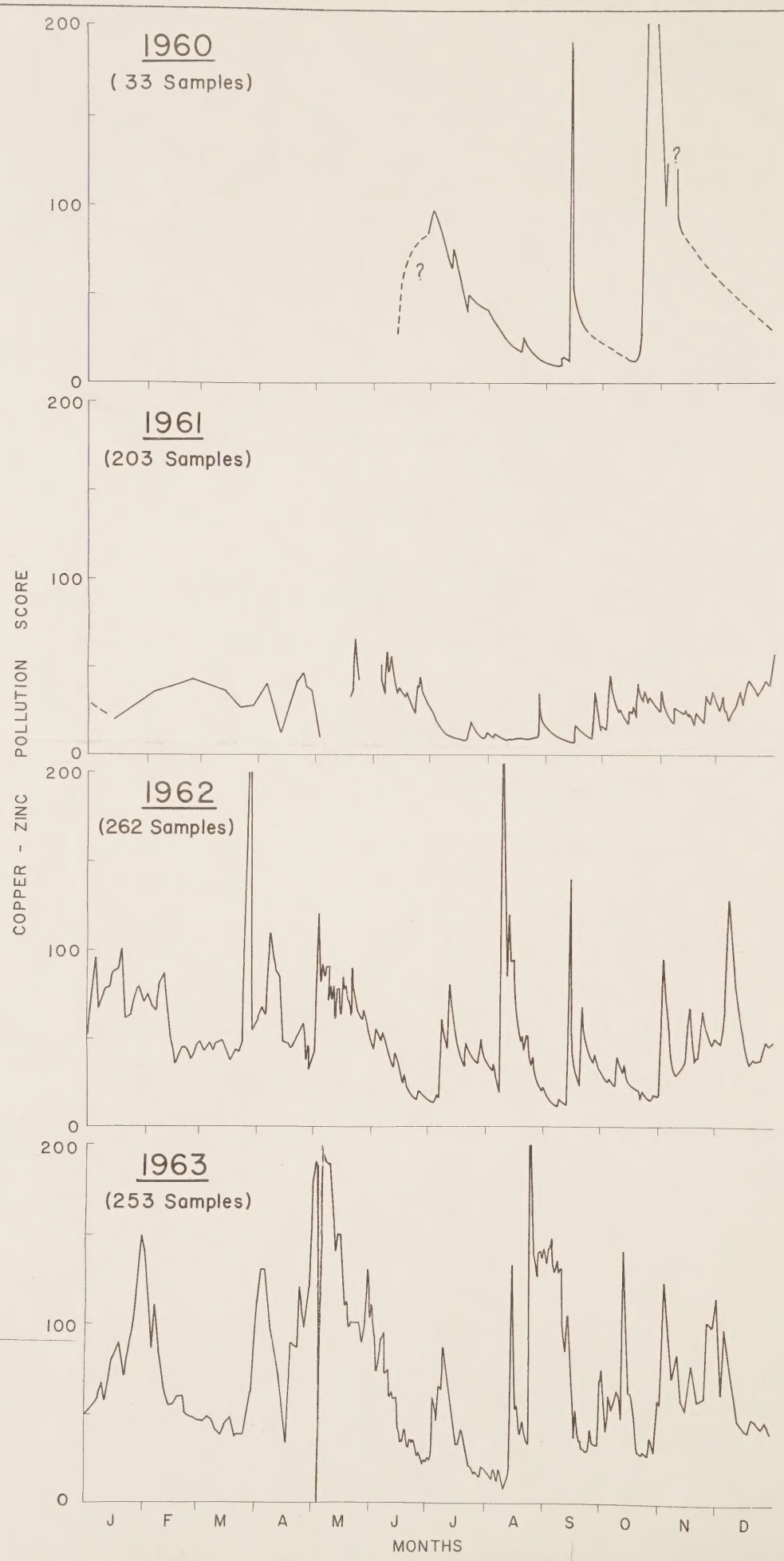
On the other hand, natural water contains a little dissolved metal. We have found that unpolluted waters from the Maritime provinces usually have a score between 2 and 10 for total copper-zinc content. This may be regarded as normal clean water.

Salmon avoid copper-zinc pollution at less than half the lethal levels. Scores higher than 35 or 45 disturb the spawning migration of adult salmon in the Northwest Miramichi. Apparently the fish dislike such water and attempt to avoid it by swimming back downstream.

The scoring system is not quite perfect. The effects mentioned above are for summer-time water temperatures. In cold water, zinc and copper seem to be less toxic to fish. It is possible that the scores we show in this circular should be reduced by about one third for the spring and autumn, and perhaps by as much as one-half for the winter. We are doing experiments to pinpoint this effect. Fish would also show slightly greater resistance to metals if they were allowed to acclimate gradually, or "get used to" non-lethal concentrations.

Pollution Scores 1960-1963

At the time of writing, we have chemical analyses of samples collected in the Northwest Miramichi up to the end of 1963. Detailed pollution scores are given in the graph on the second page. The daily


1960
(33 Samples)
1961
(203 Samples)
1962
(262 Samples)
1963
(253 Samples)
200
100
0
?
COPPER - ZINC POLLUTION SCORE
J F M A M J J A S O N D
MONTHS

Average monthly scores for copper-zinc pollution
from June 30, 1960 to the end of 1963

	1960												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Samples						1	8	7	7	6	3	1	33
Minimum						88	47	13	12	14	74	41	12
Maximum						88	98	33	190	380	120	41	380
Average						88	63	22	50	180	100	41	77
	1961												
Samples	1	2	3	7	7	26	29	29	27	30	26	16	203
Minimum	20	35	28	13	10	25	6	6	6	15	12	18	6
Maximum	20	43	36	46	65	59	29	39	39	48	36	42	65
Average	20	39	31	36	36	40	14	11	14	28	25	30	24
	1962												
Samples	13	12	13	13	30	30	31	31	30	31	15	13	262
Minimum	60	34	36	31	49	14	13	20	12	15	29	35	12
Maximum	100	86	270	110	120	57	85	230	140	45	95	130	270
Average	77	53	63	59	74	33	44	56	37	26	49	57	49
	1963												
Samples	13	12	13	13	24	30	31	31	29	31	13	13	253
Minimum	57	46	36	33	1	21	14	8	28	25	50	39	1
Maximum	150	140	61	130	200	110	80	310	150	140	120	110	310
Average	85	70	44	95	120	54	38	61	81	52	74	57	67

fluctuation is great, and depends on weather, especially rainfall, as well as mining activity and pollution control measures.

The most general way to summarize pollution is by years. The average pollution scores for the four years are as follows:

1960	:	77
1961	:	24
1962	:	49
1963	:	67

Sampling during 1960 was not frequent; only 33 samples were taken, all during the last half of the year. Most of these were obtained during freshets, when pollution was high, so the average may be a little on the high side of the true value.

A more detailed description explains the situation better. Monthly averages are given in the table, as well as day-to-day values in the graph. Scores of almost 100 were recorded in early summer of 1960; then pollution dropped off until the autumn rains, when scores rose again and averages of 50, 180, and 100 were obtained in September, October, and November. Unfortunately these numbers were based on only a few samples.

Pollution was low in the dry year of 1961 when the mine was not in production. Monthly averages were always 40 or less, and no single sample was higher than 65.

In January 1962, pollution scores jumped as high as 100, and averaged 77 for the month. High levels continued throughout 1962, with most monthly averages above 50, and all but three above 40. Fortunately the lowest monthly averages in 1962 were in June, September and October, some of the crucial months for upstream salmon migration.

Pollution scores have been higher in 1963. Nine months out of 12 had average scores higher than the same months in 1962. However a large run of salmon went upstream during the second half of June and early July 1963, when pollution fortunately dropped below 40. High pollution scores during late August and early September coincided with a scarcity of "fall-run" salmon going up the river.

The deterioration of the mining pollution situation in the Northwest Miramichi in 1963 has led to an urgent search for a completely satisfactory method of eliminating the cause, and a desire to implement it at once. Federal and Provincial authorities are involved in the work, as well as the mine operators themselves. Until this is successfully accomplished, the salmon stock in one of our best rivers remains exposed to a dangerous situation.

References

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Additional copies of this circular may be obtained by writing to the Director of the Biological Station at St. Andrews. Results presented in this circular are based on chemical determinations presented in detail in manuscript reports. A few copies of these reports are available for those doing similar work.